

Claims:

1           1.       A structure formed with a template defining a pattern having nanoscale features  
2 that may be positioned on a substrate, the template including a resist layer having openings  
3 formed therein, where the template is configured to accommodate the controlled assembly of  
4 nanoscale objects.

1           2.       A structure according to Claim 1, wherein the template is configured to aid in the  
2 positioning of nanoscale objects about the template and proximal to the substrate.

1           3.       A structure according to Claim 1, wherein the template is configured to be  
2 removed from the substrate without removing the nanoscale objects.

1           4.       A structure according to Claim 1, wherein the template is configured to  
2 accommodate the growth of nanoscale objects through the openings.

1           5.       A structure according to Claim 4, wherein the template is configured to  
2 accommodate the growth of a nanoscale wire outward from the surface of the substrate through  
3 the openings.

1           6.       A structure according to Claim 4, wherein the template is configured to  
2 accommodate the growth of a nanoscale object in a predetermined orientation with respect to the  
3 surface of the substrate through the openings of the template.

1           7.       A structure according to Claim 4, wherein the template serves as a guide to  
2 accommodate the growth of a nanoscale object in a predetermined orientation with respect to the  
3 surface of the substrate.

1           8.       A structure according to Claim 1, wherein the template is configured with  
2 openings to receive a deposition of nanoscale objects.

1           9.       A structure according to Claim 1, wherein the nanoscale objects are a film  
2 configured to coalesce when heated.

1           10.      A structure according to Claim 1, wherein the nanoscale objects are deposited on  
2 the template by a method chosen from at least one of the group consisting of, Langmuir-  
3 Blodgett, self-assembly, evaporation, electrodeposition, electroless deposition, dipping, spraying,  
4 physical bonding, and chemical bonding.

1           11.      A structure according to Claim 1, wherein the nanoscale objects are chosen from  
2 at least one of the group consisting of molecular film, electroplated film, nanowires,  
3 nanoparticles, nanorods, nanotubes, fullerenes, viral particles, polynucleic acid, polypeptides,  
4 proteins, DNA, quantities of polynucleic acids, and liquids.

1           12.      A structure according to Claim 1, wherein at least one of the openings are of a  
2 shape chosen from a group including cubic, elongated, equiaxed, triangular, and cylindrical.

1           13.      A structure according to Claim 1, wherein the size and shape of the openings are  
2 predetermined.  
3

4           14.      A structure according to Claim 13, wherein the size and shape of at least one of  
5 the openings are chosen to accommodate a particular size and shape of a nanoscale object.

1           15.      A structure according to Claim 13, wherein the size and shape of at least one of  
2 the openings are chosen so as to exclude nanoscale objects of a particular size range.

1           16.     A structure according to Claim 13, wherein the size and shape of at least one of  
2     the openings are chosen to accommodate a plurality of nanoscale objects of a particular size in  
3     one opening, and to accommodate nanoscale objects of another size in another opening.

1           17.     A structure according to Claim 13, wherein the size and shape of at least one of  
2     the openings are chosen to accommodate a specific maximum number of nanoscale objects.

1           18.     A structure according to Claim 13, wherein the size, shape, and position of at least  
2     one of the openings are chosen to accommodate a plurality of nanoscale objects substantially  
3     arranged in a predetermined orientation.

1           19.     A structure according to Claim 13, wherein the size and shape of at least one of  
2     the openings are chosen to accommodate nanoscale objects in a predetermined range of  
3     orientation coordinates.

1           20.     A structure according to Claim 13, wherein the size, shape, and position of at least  
2     one of the openings are chosen to accommodate nanoscale objects in a predetermined  
3     arrangement, such as for example a square arrangement, other than a naturally occurring  
4     arrangement, such as a triangular close-packed arrangement.

1           21.     A structure according to Claim 13, wherein the size and shape of at least one of  
2     the openings are chosen to accommodate nanoscale objects of different sizes within separate  
3     levels within an opening..

1           22.     A structure according to Claim 13, further comprising a multiple level nanoscale  
2     opening having a smaller opening within a larger opening and configured to accommodate  
3     different sized nanoscale objects within the different sized openings.

1           23.     A structure according to Claim 1, wherein the structure is positioned on a  
2     substrate having components located thereon, the template including a resist layer having  
3     openings formed therein and configured to position nanoscale objects to contact and  
4     conductively expose the components on a surface of the template opposite the substrate.

1           24.     A structure according to Claim 1, wherein the structure is positioned on a  
2     substrate having components located thereon, the template including a resist layer having  
3     openings formed therein and configured to position nanoscale objects to contact and  
4     conductively expose the components to other components located on a surface of the template  
5     opposite the substrate.

1           25.     A structure according to Claim 1, wherein the structure is positioned on a  
2     substrate having conductive wires located thereon, the template including a resist layer having  
3     through-vias formed therein to aid in the positioning of nanoscale objects in a manner to contact  
4     and conductively expose conductive wires located on a surface of the template opposite the  
5     substrate.

1           26.     A method of fabricating ordered patterns of nanoscale objects on a substrate  
2     surface comprising:  
3             applying a layer to a substrate surface;  
4             stamping an imprint mold onto the layer; and  
5             releasing the imprint mold to expose a template having a template surface formed into the  
6     imprint resist layer and having nanoscale openings formed therein to receive nanoscale objects.

1           27.     A method according to Claim 26, further comprising selectively removing  
2     residual layer material from the substrate surface to expose a template having a template surface  
3     formed into the imprint resist layer and having nanoscale openings formed therein to receive  
4     nanoscale objects.

1           28.     A method according to Claim 26, further comprising:  
2           applying a first set of nanoscale objects to the template surface in a manner to cause one  
3           or more of the nanoscale objects to be proximal to the substrate surface through the nanoscale  
4           openings.

1           29.     A method according to Claim 28, wherein at least one of the first set of  
2           nanoscale objects remains outside of the openings and wherein at least one of the objects  
3           contacts the substrate surface.

1           30.     A method according to Claim 29, further comprising:  
2           removing the nanoscale objects that remain outside of the openings.

1           31.     A method according to Claim 30, further comprising:  
2           removing the nanoscale objects that remain outside of the openings with a chemical  
3           wash.

1           32.     A method according to Claim 26, wherein the nanoscale openings are ordered in a  
2           pattern with respect to at least one of the group consisting of size, shape, orientation, pattern, and  
3           position.

1           33.     A method according to Claim 26, further comprising selectively removing a  
2           residual portion of the resist layer from the substrate surface.

1           34.     A method according to Claim 28, further comprising removing the template from  
2           the substrate surface.

1           35.     A method according to Claim 28, further comprising initiating a linear or non-  
2           linear growth of the one or more nanoscale objects.

1           36.     A method according to Claim 28, wherein the first set of nanoscale objects is  
2 comprised of DNA, polynucleic acid, polypeptides, or a layer of chemistry.

1           37.     A method according to Claim 36, wherein the DNA, polynucleic acid,  
2 polypeptides, or a layer of chemistry are further used in chemical sensing applications or as  
3 scaffolding material to construct biomolecular architectures.

1           38.     A method according to Claim 28, wherein the first set of nanoscale objects are  
2 each configured to accommodate molecular attachment

1           39.     A method according to Claim 28, further comprising depositing a second set of  
2 nanoscale objects to a surface of the template.

1           40.     A method according to Claim 39, wherein the first set of nanoscale objects is of a  
2 different size than the second set of nanoscale objects.

1           41.     A method according to Claim 26, wherein the stamping is performed by a step  
2 and flash lithographic method.

1           42.     A method according to Claim 28, wherein the nanoscale openings are configured  
2 in a predetermined pattern.

1           43.     A method according to Claim 42, wherein the pattern is symmetrical.

1           44.     A method according to Claim 42, wherein the pattern is nonsymmetrical.

1           45.     A method according to Claim 42, wherein the pattern contains at least one  
2 symmetrical pattern.

1           46.     A method according to Claim 42, wherein the pattern contains at least one  
2 nonsymmetrical pattern.

1           47.     A method according to Claim 42, wherein the pattern contains at least one  
2 periodic pattern.

1           48.     A method according to Claim 42, wherein the pattern contains at least one  
2 nonperiodic pattern.

1           49.     A method according to Claim 26, wherein the openings are of one or more  
2 predetermined sizes.

1           50.     A method according to Claim 26, wherein the openings are of one or more  
2 predetermined shapes.

1           51.     A method according to Claim 26, wherein the openings are positioned in one or  
2 more predetermined orientations.

1           52.     A system for making a structure having an ordered pattern of nanoscale features  
2 on a substrate surface, comprising:

3                     a template with the ordered pattern of nanoscale features on a substrate surface;

4                     and

5                     means for applying nanoscale objects about the template in a manner

6                     to cause the nanoscale objects to contact or be proximal to the substrate surface.

1           53.     A system according to Claim 52, further comprising:

2                     means for creating the template includes means for creating a template utilizing a

3                     mold.

1           54.     A system according to Claim 53, wherein the means for creating a template  
2     utilizing a mold includes means for creating a mold by carving a wafer in an inverse of the  
3     ordered pattern.

1           55.     A system according to Claim 53, wherein the means for creating a template  
2     utilizing a mold includes means for creating a mold by carving a wafer in a shape  
3     complementary to the ordered pattern.

1           56.     A system according to Claim 54, wherein the wafer is composed of one of the  
2     group consisting of metal, silicon, plastic, glass, and quartz.

1           57.     A system according to Claim 55, wherein the means for creating a template  
2     utilizing a mold includes means for creating a mold from a wafer utilizing an electron beam.

1           58.     A system according to Claim 55, wherein the means for creating a template  
2     includes means for creating a template using thermal imprint lithography.

1           59.     A system according to Claim 52, wherein the nanoscale features provide vias  
2     through the template.

1           60.     A system according to Claim 52, further comprising conductive means located on  
2     the substrate, and through-vias within the template configured to accommodate nanoscale  
3     particles that can conductively expose the conductive means on an opposite side of the template.

1           61.     A system according to Claim 52, wherein further comprising conductive means  
2     located on the substrate, and through-vias within the template configured to accommodate  
3     nanoscale particles that can conductively expose the conductive means to other conductive  
4     means located on an opposite side of the template.



1           62.     A system according to Claim 59, wherein the vias connect wires located on  
2 opposite sides of the template when nanoscale particles are deposited within the vias.

1           63.     A system according to Claim 52, further comprising means for applying a second  
2 set of nanoscale objects about the template in a manner to cause the second set of nanoscale  
3 objects to contact or be proximal to the first set of nanoscale objects.

1           64.     A system according to Claim 59 wherein the vias connect electrical devices.

1           65.     A system according to Claim 52, wherein the nanoscale objects provide electrical  
2 function including those chosen from the group including simple electrical connection,  
3 rectification, Coulomb blockade, switching, amplification, memory, and impedance.

1           66.     A system according to Claim 65, wherein the electrical function is provided by  
2 the nanoscale objects in conjunction with any elements to which they are connected or proximal.

1           67.     A method of using a template to fabricate ordered patterns having nanoscale  
2 features on a substrate, said method comprising the steps of:

3           applying an imprint resist layer to the substrate;

4           stamping an imprint mold onto the imprint resist layer;

5           releasing the imprint mold;

6           selectively removing residual resist material from the substrate to expose a template  
7 having a template surface formed into the imprint resist layer and having openings formed  
8 therein; and

9           applying nanoscale objects to the template in a manner to cause the nanoscale objects to  
10 be proximal to the substrate through the openings.

1           68.     A method according to Claim 67, wherein the nanoscale objects contact the  
2 substrate and operate as ball bearings with respect to aligning a second template relative to the  
3 template.

1           69.     A method of using a mold to fabricate a template of an ordered pattern having  
2 nanoscale features, said method comprising the steps of:  
3           applying an imprint resist layer onto a substrate;  
4           using the mold to stamp the ordered pattern into the resist layer;  
5           removing the mold; and  
6           removing residual resist material from the substrate to expose the template of the ordered  
7 pattern, where the template is configured for assembly of nano scale objects.

1           70.     A method of positioning at least one nanoscale object, comprising:  
2           providing a template having at least one nanoscale opening, the opening being created by  
3 use of an imprint lithography process; and  
4           applying nanoscale objects to the template in a manner so that at least one of the  
5 nanoscale objects at least partially enters the opening.

1           71.     The method of claim 70, further comprising:  
2           after the applying step is performed, removing the template.

1           72.     The method of claim 70, further comprising:  
2           prior to providing the template, creating the opening in the template using the imprint  
3 lithography process.